

commoner have turned up again in the Red Sea, as have many of those conspicuous forms which are at once recognizable by their colour or tubes.

Plant life resembles that of Equatorial East Africa, in that most of the species are the same, but occur in different proportionate quantities. The absence of coral on the East African reefs is correlated with the vast quantities of the marine phanerogam *Cymodocea ciliata*, Ehrenb., which there occupy the spaces here covered with coral, but even on mud or sand-areas this species is not often met with on the Red Sea coasts. The true seaweeds are the same, but again there is far less ground suited to *Halimeda* spp., which are consequently less frequently met with and then in less abundance.

On shore Mangroves are absent, perhaps because there is no tidal action to plant their floating embryos. Its companion *Jussiaea*, with its aerial peg-like roots, is frequently found, but not often in large numbers.

The salt pools found here and there on these arid coasts soon evaporate to a slush of salt crystals, and in these a red microscopic alga flourishes to such an extent as to colour the whole pool. Whether the name "Red Sea" is given from this alga or from the pelagic form which makes a scum as if of iron rust over large areas of the sea occasionally during calms, or from the brown Xeniidæ which carpet the harbour sides, is indeterminable; any one of the three is a striking phenomenon, the first being obvious to shore dwellers, the second to sailors. Perhaps after all, the name was given by landsmen who noted the prevalence of red colour in the hills which border the sea throughout its length.

REPORTS on the MARINE BIOLOGY of the SUDANESE RED SEA.—III. NOTE on the FORMATION of the SHORE-CLIFF near ALEXANDRIA. By CYRIL CROSSLAND, M.A., B.Sc., F.Z.S. (Communicated by Prof. W. A. HERDMAN, F.R.S., P.L.S.)

(PLATES 2 & 3.)

[Read 2nd May, 1907.]

THE *Coast of the Delta* is in the form of an arc of a circle except on its west side, where it runs almost in a straight N.E. and S.W. line from Alexandria to Abukir. These two sections of the coast differ markedly, the former having a very low and sandy shore generally backed by swamps or lakes, the delta being in process of extension, the latter being bounded by low cliffs due to the rapid erosion of the land by the sea. (See Plate 2. figs. 1 & 3.)

The cliffs, with an exception to be noted later, are of the softest material throughout, yet always nearly vertical; a fact the significance of which one would have supposed could not have escaped the notice of the builders of the

numerous villas which have recently occupied the sea-front at Ibrahimieh and elsewhere on this coast.

The cliffs, like the desert of which they represent sections, are formed of wind-blown sand containing in places stones formed by the consolidation of the same material. This is laid down in strata of various thicknesses dipping and curving in all directions. A cutting for the electric railway just beyond Palais Station shows thin laminæ of just consolidated sand; thicker strata, of hard rock, are exposed on the beach.

The material is, in all cases, coarsely ground shell-fragments, the land being thus of marine origin.

The greater bulk of the material above sea-level between Alexandria and the "Sporting Club," a distance of two or three miles, is composed of the rubble, mud and broken pottery remaining from the decay of the ancient suburbs of Alexandria. Plate 2. fig. 2 shows a section of this deposit at its greatest thickness. The ground has been reduced to its ancient level artificially, as shown by the pit in the foreground, which exposes the natural sandstone; and the hill owes its preservation to the strong feeling of the Moslems against the removal of the graves of two Sheikhs which occupy the ground. The headstones of these graves being 7 feet in height, the hill is about 60 feet. It is composed from top to bottom of rubble, &c., and numerous fragments of red pottery.

At this point the rubble deposit does not reach sea-level, but as the original sand dunes were undulating so the level of the beginning of this formation varies—from sea-level to a height of 60 feet or more above it. But generally in the neighbourhood of Ibrahimieh the greater part of the cliff is composed of these remains. (See Plate 2. fig. 3.) It seems very remarkable how rarely larger stones, such as are invariably used in modern houses, are found among these fragments, but such walls as remain intact embedded in the cliffs are invariably composed of rubble and other materials similar to those used in the walls of the poorer native houses of the present time.

Returning to figs. 1 and 3, a distinct lower layer is seen in the cliffs more or less regularly throughout their length. This is generally a more coherent and homogeneous sand than that above, which contains loose stones. Lower down the beach this passes into sandstone of considerable hardness. As a rule there is a beach of loose sand between the cliffs and the hard rock, which more often, but not always, begins about low-tide level (tides rise 2 feet at springs); but where a continuous bed extends from the cliff to the low-tide level, the interesting point is shown that, simultaneously with the discoloration of the surface under the influence of the sea, a hardening occurs. The light yellow rocks can easily be dug into with the point of a penknife. At the higher level of the blackened area this is possible after the surface layer is removed. Further down the shore the rock can only be scratched by the knife with difficulty though remaining soft inside; the origin of the hard

rock found below high-tide level is apparently a cementation of the sand by deposition of mineral matter from the sea-water, in the same way probably as in the case of the beach sandstone of the Khor Dongola Islands (p. 24 *et seq.*) (Pl. 1, fig. 3 and its explanation).

Any calcareous matter may be hardened in this way. In places, masses of the rubble of ancient Alexandrine suburbs come to lie below sea-level*, and have been cemented into a breccia containing broken pottery. Such is the origin of the rocks in the foreground of fig. 1 (Pl. 2), while those in the near distance are of homogeneous sandstone.

Between tide-marks the shore forms a rock-flat, cut up into pools, and with areas of sand bound together by luxuriant patches of phanerogamous weeds. About Ibrahimieh this flat is artificially regular through the operations of the ancient Alexandrians, who filled the ground with graves and catacombs the bottoms of which now remain exposed in the shore-flat, the sea having invaded a large part of the great eastern necropolis. Plate 3, fig. 1 shows a catacomb passage just above high-tide level. There are side branches to right and left in which the niches for the dead are plainly seen. Further down the shore the graves remain as shallow troughs cut in the rock. The graves spared by the sea are now being carefully despoiled prior to the division of the cemetery into desirable building lots.

Further west the levelling of the shore seems to be the result of quarrying operations rather than of grave-digging.

Along the seaward edge of this rock-flat is a series of masses of harder rock, which, having undergone further hardening under the action of the waves, are being eroded but slowly. Below water-level the edge of the flat is protected by an incrustation very similar to that I described as occupying the same position in the Cape Verde Islands †. The same species of *Vermetus* is here, but

- (1) It never forms masses alone.
- (2) There is no gradation between the proportions of nullipore and *Vermetus* such as is characteristic of sheltered and exposed situations in the Cape Verdes.
- (3) The incrustation consists largely of Serpulid, *Sabellaria*, and Terebellid tubes, which was never the case in the Cape Verdes. The latter two being sandy are a source of weakness.
- (4) The incrustation never contains a high proportion of nullipore. Large masses of nullipore are not found; and the species which covers the

* There seems to have been a sinking of the coast, *cf.* the ruins found out at sea near ancient Canopus, and the now submarine catacombs and excavations of the shore near Ibrahimieh. But of course masses of débris might reach their present position by local subsidence of portions of the cliffs.

† Proc. Zool. Soc. 1905, vol. i. p. 178.

exposed rocks of the Cape Verdes does not occur here. Jointed "Coralline" is very abundant everywhere on the outside of the incrustation.

Specimens of this growth, even those collected within a hundred yards of each other, show differences in the constituents and the proportions in which they occur.

There are two species of *Vermetus*: a smaller with long tube often largely free from the substratum, and a larger with shorter tube forming a coil adpressed to the substratum. The former is the more important here, and is the important organism of the Cape Verdes; the latter occurs usually near high-tide mark and does not often enter into the incrustation, though in some cases it forms the bulk of the mass.

The proportion of sandy tubes of *Sabelliformia* and *Terebellidæ* is an important point, as they are a cause of weakness. They do not generally, however, occur in so high a proportion as to destroy the coherence of the whole when maceration removes their binding material.

The proportion of Serpulid tubes, of several species, is always high, often forming fully half the whole mass. Nullipore, as noted above, is low. Hence the comparative weakness of the whole in comparison with the Cape Verde material, which consisted of the two strongest ingredients practically alone. The contrast would be far greater but for the abundance of boring sponge and annelids in the latter locality.

That the shore platform owes, if not its existence, at least its definite edge to this growth is self evident, but a remarkably clear case is afforded by the rocks photographed and shown in Pl. 3. fig. 2. At a point about a mile east of the Palais station on the Ramleh Railway, *i. e.* about 5 miles east of Alexandria, the rock is both higher and harder than usual on this coast, though formed of the same broken shell material. The headland thus resulting projects into comparatively deep water and is exposed to the full force of the waves. The photograph was taken during the retreat of a wave, and shows very clearly the extremely regular shelf which borders the rocks. The form of the rocks above water-level should be noticed. They show clearly the same weathering which is so characteristic of the "Coral-Rag" of the Tropics, and at this level they have taken on the same extreme hardness.

1



2



3





FIG. 1.



FIG. 2.

C. C. Photo.

Grout, Engr.

CLIFFS NEAR ALEXANDRIA.